action orientated. The results were stimulating. Over the first week production rose from ± 15 to ± 24 units per day with no returns or rejects. After 2,5 to 3 weeks however, the old system started creeping back in. At this stage a short in-house revision course was presented followed by a day of on-the-floor action orientated training. In addition, a problem solving group was formed. This group included the 8 assemblers and the training officer. The author sat in on the meetings but did not participate other than as a go-between with middle management.

The group met twice a week for 30-minute meetings. At the meetings, which were chaired by a leader chosen by the group, issues relating to quality problems, component supply problems, general improvements, housekeeping, line balancing, jigs, maintenance and any other topic directly affecting the JIT effort of the line, were discussed.

Materials that were initially stacked at the workplace were removed to a central component store. The storekeeper would then supply the line with enough components for 1 week's production, and 2 months later, after the introduction of Kanban, enough components for only one day's production. (The introduction of Kanban cards is discussed in section 4.5.3)

In order that there were no serious fluctuations in the assembly rates on the line, a final assembly schedule was drawn up by production control. The assembly schedule took into consideration two important points. The first was that the schedule was kept as stable as possible such that Kanban systems could be introduced later. (The Kanban system requires stable schedules as a prerequisite to successful operation [82]). The daily schedule was identical for each day of the month in terms of production quantities. The daily rates were determined by dividing the number of units required for the month by the number of working days in the month. The second point is that under capacity scheduling was practiced in order that an unpleasant sweatshop environment did not develop. Maximum production on the line was set at 22 units per day. If the schedule demanded more units on a daily basis more workers would be recruited from other assembly areas and a temporary line set up to cope with the overload. The low volume high variety items were completed on the temporary line. Under capacity scheduling had the added advantage of allowing extra time for attention to be directed at tasks such as housekeeping and working on problem solving group activities.

Kanban squares on the shop floor were also introduced. These Kanban squares signalled to the storekeeper that more parts were required at the line. These Kanban squares at the line were filled once per day, generally before morning start up. Only one day's production filled the square. The Kanban squares were in fact moveable trolleys. This was a necessary development of the Kanban square concept because the line was not dedicated, thus different models were run down the same line and since each had a different set of components, the assembly line supply system had to be adjusted accordingly. (The Kanban Trolley concept is described in section 4.6.5). On average the inventory holding at the line was reduced from 30 different components to about 15 components and only 1 day's supply i.e. $\pm$22 units of each, rather than the previous lot size of $\pm$400 units. Since the components had been moved away from the line to the store, the store was now becoming overloaded. The shift of inventory away from the line to the store did essentially not contribute to reduced inventory levels but rather served to aid the assembly of the units as the zone was less cluttered. Visibility was thus enhanced.

Although "mixed model" production was not initially included in the system, the line was able to produce approximately 70% (by type) of the bedroom suites after small reshuffles of tasks to keep the line balanced. Since workers were not trained in simple Industrial Engineering tasks like line balancing and time studies, it was necessary for the production management to help in the reshuffling of the line at each model change. During the first three months of operation the line produced the same bedroom suite for up to 10 consecutive days depending on the amount required by the monthly customer order total. The second quarter saw the splitting of monthly production quotas into two runs. By December 1987 runs lasted between 4 hours and 1 day before the model was changed. The system allowed for a few of each bedroom suite to be produced each week, rather than one lump sum at the end of each month.

Some of the improvements that were made during this project (from Feb 87 to Feb 88) are summarized in Table 2 for easy comparison.

	ORIGINAL	J-I-T	IMPROVED
Flowline Legngth	30 metres	15 meters	50%
Assembly Leadtime	10 days	1 day	90%
Labour Compliment	8 workers	8 workers	0%
Rework Rate	2 units/day	Nil	100%
Assembly Rate	15 units/day	22 units/day	47%
Approx WIP at Line	12000 components	330 components	97%

TABLE 2: Improvements due to headboard line pilot project

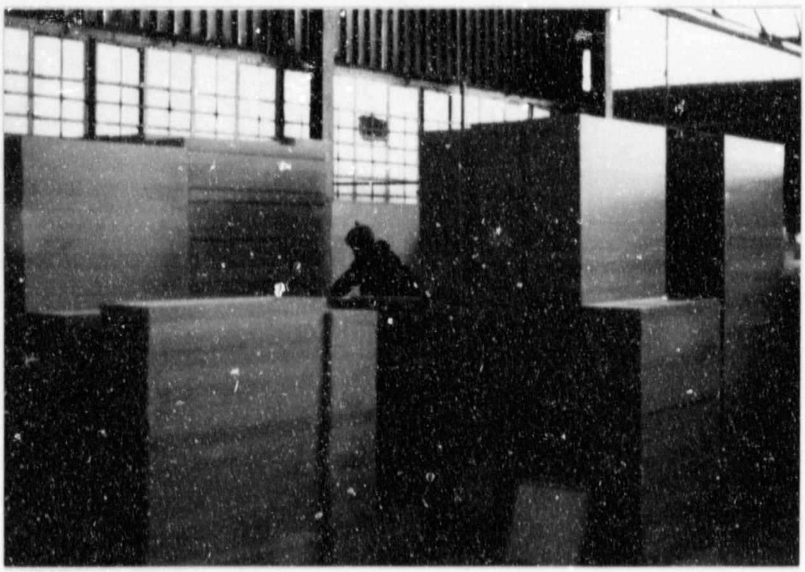
Approximately two months after starting the bedroom suite pilot project the steering committee decided to start a similar project on the kist assembly line.

4.5.2 The Kist Line

A.F. Dreyer & Co. produces approximately 1100 kists per month [Appendix C2], which accounts for approximately 37% of the company's average monthly sales units. The kist line with the bedroom suite line, which produces 460 headboards, 300 dressing tables and 430 stools [Appendix C3, C4 and C5], together make up close to 80% of the company's end products. Since these two lines together made up a substantial portion of the flow volume through, not only the assembly shop, but also the polish shop and the component fabrication shop, it was decided that a second pilot project would be set up in the kist assembly shop. The kists however, were split into two entirely separate categories namely solid kists and fibreboard or junior type kists. The solid imbuia type kists were assembled in a different manner to the fibreboard kists. The junior (fibreboard) type kists accounted for approximately 60% of the flow volume. In addition to the relatively high volumes the assembly process for the junior kists was simpler. The second pilot project was directed at the junior kist assembly line.

Prior to the introduction of the JIT concept to the line, as with the bedroom suite line, the assembly was carried out in large lots. For example, if an order for 500 Junior kists was received, the machine shop would fabricate 500 of each component (with appropriate multiples for the BOM quantities) and send the entire stock to the assembly department. In the assembly department 500 kist lids would be assembled, followed by 500 kist carcasses. Only after all the kist lids and kist carcasses had been completed would the lids be fitted to the carcasses. [See Print 3, page 77] After the lids were attached to all 500 kists, legs would be fitted. The trimming was then attached, and the 500 kists would be moved from the assembly shop to the sanding shop for sanding. [See Print 5, page 79]

While those kists were being prepared for polishing the assembly department would start the assembly of 500 shelf trays for the kists. [Print 1] These would be completed by the time the kists emerged from the polish shop and final fitting would be carried out. [Print 2] The entire assembly process for 500 kists took 4 weeks or 20 working days and involved a WIP of 500 kists.



PRINT 1: Completion of 500 kist shelf trays.

The initial implementation steps as regards labour training followed the same pattern as for the bedroom suite line 2 months entire stock to the assembly department. In the assembly department 500 kist lids would be assembled, followed by 500 kist carcasses. Only after all the kist lids and kist carcasses had been completed would the lids be fitted to the carcasses. [See Print 3, page 77] After the lids were attached to all 500 kists, legs would be fitted. The trimming was then attached, and the 500 kists would be moved from the assembly shop to the sanding shop for sanding. [See Print 5, page 79]

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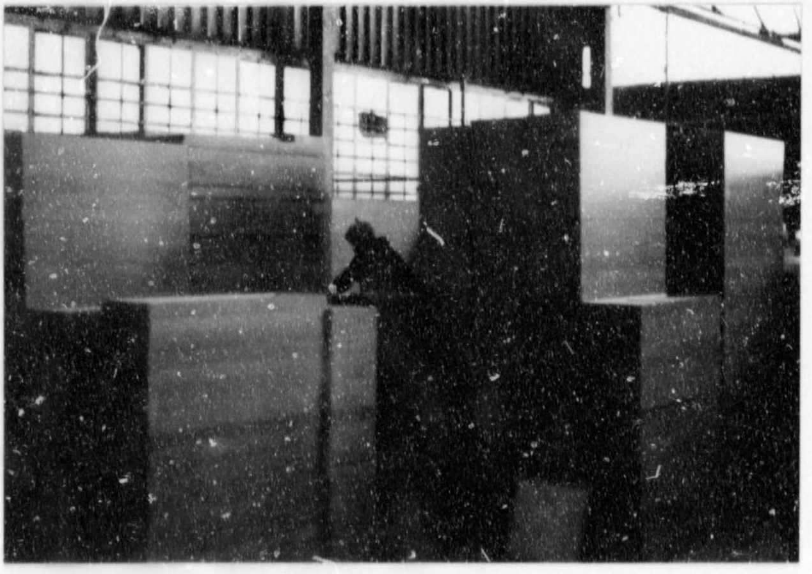


PRINT 1: Completion of 500 kist shelf trays.

The initial implementation steps as regards labour training followed the same pattern as for the bedroom suite line 2 months earlier. Since the layout and labour allocation of the kist line is more involved than the initial pilot project, the layout and system is discussed in more detail.

PRINT 2: Final fitting of a large lot of kists.

Prior to any changes being made to the line a study of the process was conducted. From this study a flow process chart was constructed for the junior kist assembly zone [Appendix D1]. This flowchart was then analysed and all non-value adding processes such as delays, storages and transportations That could be eradicated, were removed. [83] The result was an ideal flow process chart [Appendix D2]. Improvements are noted in Table 3.

	SYMBOL	ORIGINAL	J-I-T	CHANGE
Operations	○	57	50	- 7
Delays	D	86	1	- 85
Transportations	⇨	41	28	- 13
Storages	△	19	8	- 11
Inspections	□	2	50	+ 48

TABLE 3: Comparison of process flowcharts.

Based on this improved flow process chart [Appendix D2] and various constraints such as labour available, minimum space and a flow line arrangement, a layout was developed that would allow the production staff to come as close as possible to the ideal process. The layout that was developed for the junior kist assembly line is shown in Figure 15 overleaf.

Each block in the figure represents a task in the assembly process. These tasks relate to the operations on the improved process flowchart of Appendix D2.

The steering committee decided that rather than burden the sanding shop with the sanding of the kists, the sanding would be carried out during the assembly of the kists. For this reason four sanders were transferred from the sanding shop onto the kist assembly line. This brought to 12, the total labour force working on junior kists. With a labour compliment of 12 and a cycle time of 3 minutes it was estimated that for a 480 minute day, a total of 160 kists per day could be sanded and ready for polishing. This figure was not achieved since at no period during 1987 did the monthly demand warrant the assembly of more than 100 kists per day. Should the demand have justified assembling more than 100 kists per day it is doubtful whether the line would have been capable of it for 3 reasons - a) the component supply to the line was erratic both in quantity and quality, b) due to poor understanding and commitment from some of the middle management, and shop floor management workers were often removed from the line for other tasks thus upsetting the line balance and c) workers on the line were changed on numerous occasions throughout the year due to a high labour turnover rate

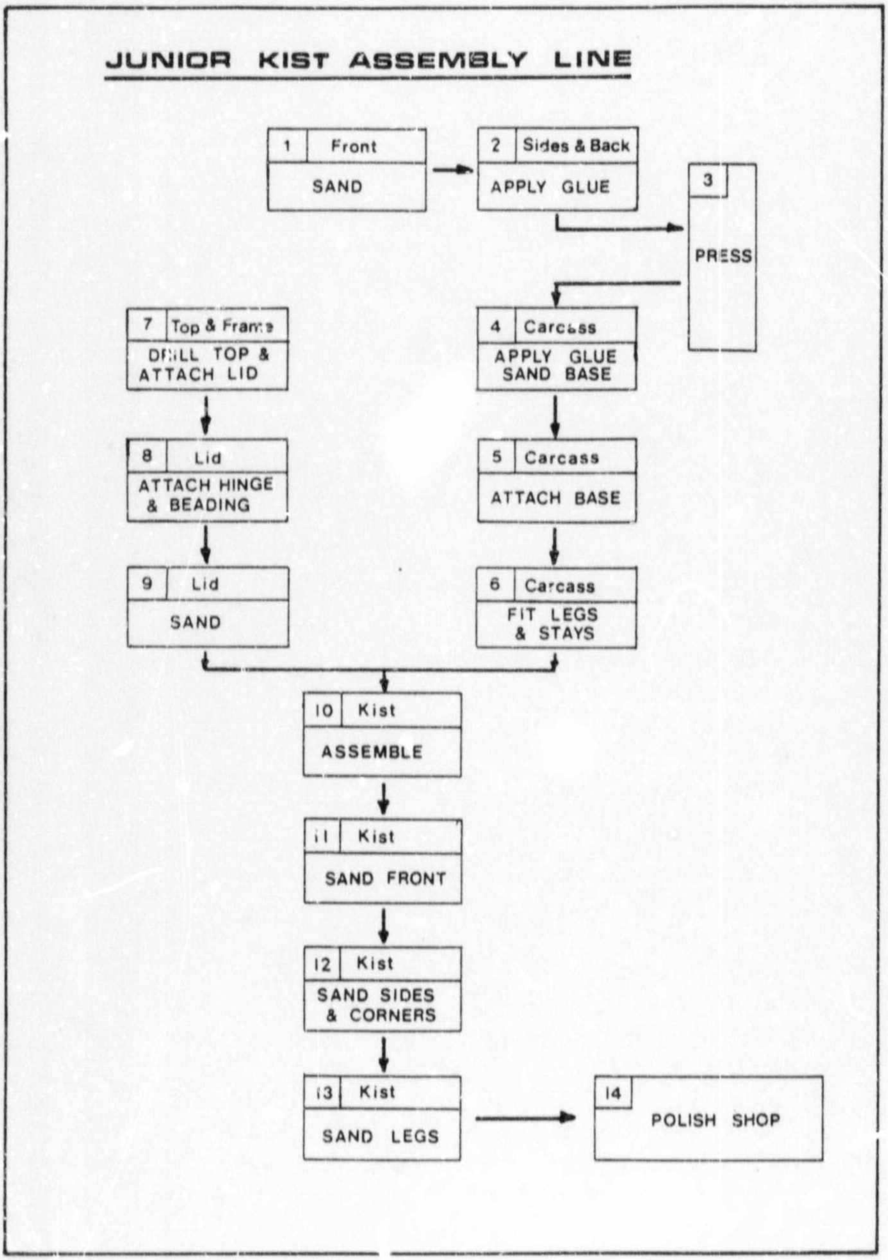
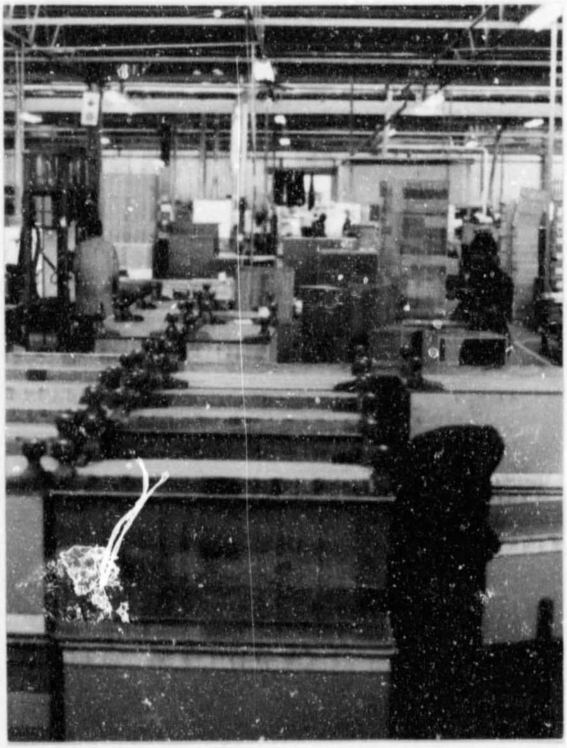


FIGURE 15: Junior kist assembly line.



PRINT 3: Old kist assembly zone.

PRINT 4: New kist assembly zone.

and an absenteeism average of well over 14%. In practice the line assembled ±80 kists per day.

The Just-in-Time kist assembly process was carried out following the flowchart presented in Appendix D2. It was possible to eradicate most of the delays and storages in the system simply by reducing the assembly lot size to one unit irrespective of the quantity of kists on order. Although the machine shop still fabricated the components in large lots, the component store was used as a buffer for excess inventory in exactly the same way that it was used in the bedroom suite pilot project. It was envisioned that after GT principles had been applied to the machine shop, the necessity of the component store as a buffer would be eradicated and the store would be removed. The function of the buffer was thus viewed as temporary.

Print 3 (previous page) shows a view of the assembly line from the tail end prior to changing the line. Print 4, taken 2 months after the kist project was started from exactly the same position, shows the tremendous reduction of work-in-progress, not only at the line but also in the machine shop in the background. (the reduction of inventory levels in the machine shop is discussed in section 4.5.3 which covers the Kanban card system, the third pilot project)

Print 6 indicates the sanding shop after JIT production had been adopted on the junior kist assembly line. This print shows the same area that is shown in Print 5 which was taken before the project began. The substantial drop in work-in-progress in the sanding shop can be attributed to a) the reduction in assembly

PRINT 5: Large lot of kists from assembly.

PRINT 6: Sanding shop after JIT implementation on kist assembly line.

lot size to one unit and b) the fact that kists were now being sanded as they were assembled rather than after assembly [see Figure 15].

In order to avoid overproduction at the individual assembly operations workers were taught to regard each work area as a Kanban square. Print 7 shows two workers adhering to the Kanban principle i.e.. the worker on the left has completed his "drill top - attach lid" operation [see Figure 15 operation 7]. Once this operation is complete the lid is moved to operation 8 where the second worker in the photograph attaches a hinge and a beading [Figure 15 operation 8]. The worker on the left is waiting for the worker on the right to complete his task and remove the unit on which he is working. Only after his task is complete will the first worker place the lid on the second worker's table. All workers both on the kist line and the bedroom suite line, were trained to adhere to this principle.

The Kanbar square principle described above has three primary functions :-

a) discourage overproduction and large lots,

b) change a push system to a pull system,

c) reduce work in process inventory.

PRINT 7: The Kanban square principle in action.

The pilot project on the kist line followed the implementation framework that is presented in section 2.3.1. The implementation is an ongoing process which considers the stage 1 items, then the stage 2 items then back to stage 1 items, and then back to stage 2 items in a perpetual improvement cycle. The cycle is not a rigid cycle but rather can be adapted to the progress that has been made and the enthusiasm of the employees. There is however, no single "recipe" for success in terms of the sequence of applying different techniques [Figure 1]. The kist line project and the bedroom suite project followed different implementation plans but both involved employees to a great extent.

In contrasting the old and the new kist assembly processes some substantial improvements were made within the first 3 months of operation. Table 4 shows the most important improvements.

	ORIGINAL	J-I-T	IMPROVEMENT
Flowline Legnth.	175 meters	60 meters	65%
Process Leadtime.	20 days	1 day	95%
Labour Compliment.	15 workers	12 workers	20%
Rework Rate.	10 kists/day	1 kist/day	90%
Assembly Rate.	65 kists/day	80 kists/day	23%

TABLE 4: Actual improvements on the kist line.

4.5.3 The Kanban Card Pilot Project

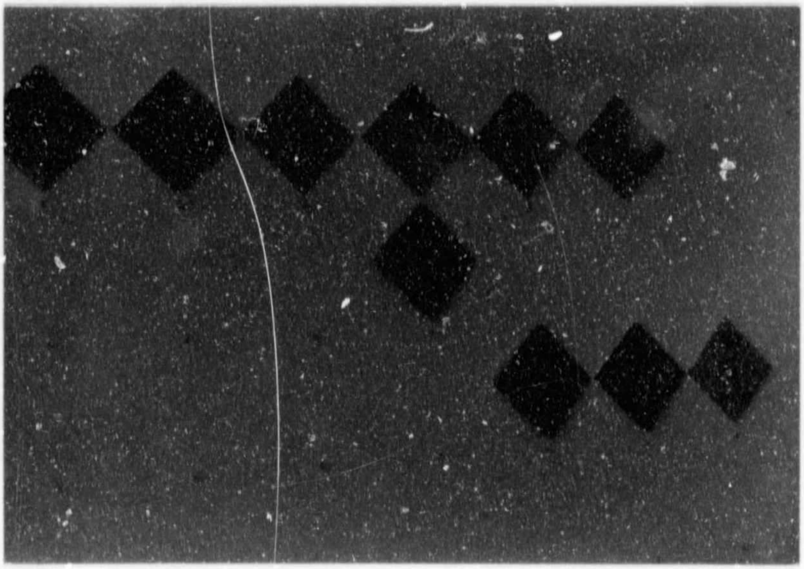
After 3 months of JIT pilot projects in the assembly department many of the other departments became interested in the system. In addition, all of the members of the steering committee had become dedicated to the new system to a large extent. There was however, some uncertainty as to how the principles would be applied to the machine shop as components were produced in discontinuous flows and in large batches. Routing information was complex and often changed. The planning and control of the machine shop was in fact in such a poor state that virtually every job that was released onto the machine shop floor had to be expedited back off it.

By May 1987 two problem solving groups had been set up, one from the bedroom suite line and the other from the kist line. Both of these groups recognised the necessity to improve the supply of components to the lines both in quantity and quality. The supply system at the time, which used the component store as a buffer between the fabrication and assembly, was inadequate and wasteful. The system simply stored the components in a central store rather than on the shop floor and did not eradicate the need for storage. Representatives from the two groups approached the steering committee to set up a pull system between the assembly shop and the machine shop.

The steering committee decided to set up a Kanban card system between the store and the machine shop. There were three reasons for this; a) the system would improve supply to the JIT assembly lines, b) for the first time JIT would be introduced to the machine shop and fabrication side of the plant and c) the staff in the component store could no longer handle the workload of counting and distributing components to the assembly lines on a daily basis and the inventory levels in the component store had reached massive proportions.

It was decided that rather than introduce the Kanban cards between the assembly line and machine shop, the cards would be introduced between the component store and the machine shop. If the system worked well, the component stores' function would not be required and only then would a Kanban system be set up between the individual lines and the machine shop.

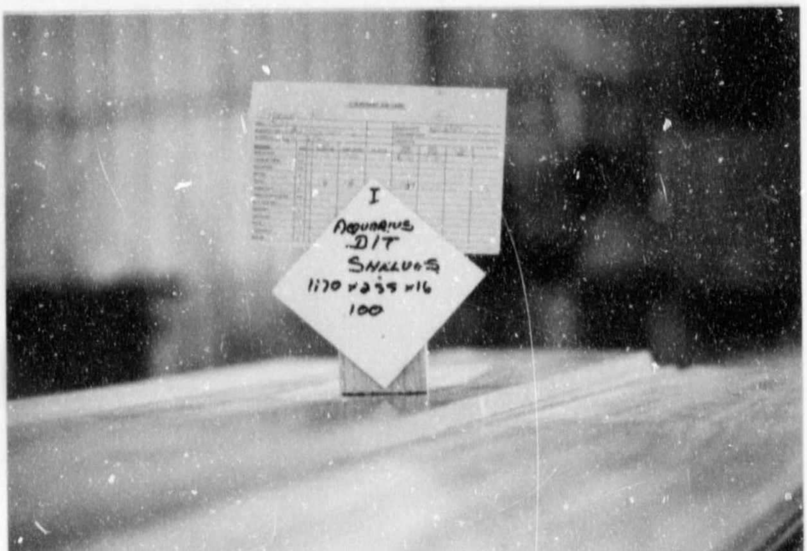
The first set of cards for the Standard and Junior kists is shown in Print 8. Although not indicated on the Kanban card, the lot size was 500 units (with BOM adjustment), or one month's supply. The pull signal worked as follows : when a card appeared on the Kanban board, it signalled that there was only the safety stock of a particular item left in the store. The reorder point was initially calculated to be ±4 weeks supply for the assembly lines. This was approximately equal to the machine shop's lead time for the component. The machine shop then removed the components' Kanban card from the board and started fabricating the components. The card followed the components through the



PRINT 8: The first Kanban cards.

routing of machines and into the component store. The storekeeper would then distribute the components to the assembly lines until the reorder point was reached. When this level was reached the card would be returned to the Kanban board by the storekeeper and would signal to the machine shop foreman that stock was again low. In essence the card acted as reorder point. Cards were initially colour coded according to the component.

The pull system worked satisfactorily but lot sizes were too large and took too long to move through the machine shop. The flat Kanban cards were also lost often so a new design was introduced. It was also decided that all components being used on either of the two JIT lines would be placed on a pull system. In addition, it was decided that the lot sizes for all of the items on Kanban cards would be reduced by 50%. A second stage Kanban card is shown in Print 9.



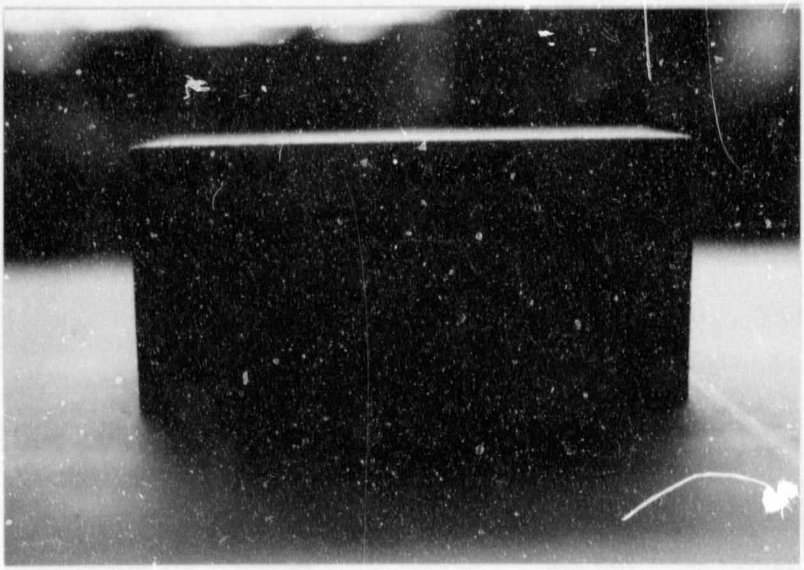
PRINT 9: Stage 2 Kanban card.

The new cards were attached to wooden blocks and stood on top of the components as they were moved through the component routings in the machine shop. Since not all of the production workers were aware of the routings for all of the components, "component job cards" were attached to the Kanban cards. These component job cards indicated the component routing and served to record queue and processing times at each workcentre.

By June 1987 approximately 500 components had been issued with Kanban cards. The Kanban cards were used not only for the kists and bedroom suites but also for desks, wardrobes, displays, video cabinets, stools and tables. Lot sizes were again dropped by 50% and each lot produced more often. The stage 2 Kanban card proved too susceptible to damage and since they were not colour coded in any way they were difficult to control [Print 10].

PRINT 10: Damaged Kanban card.

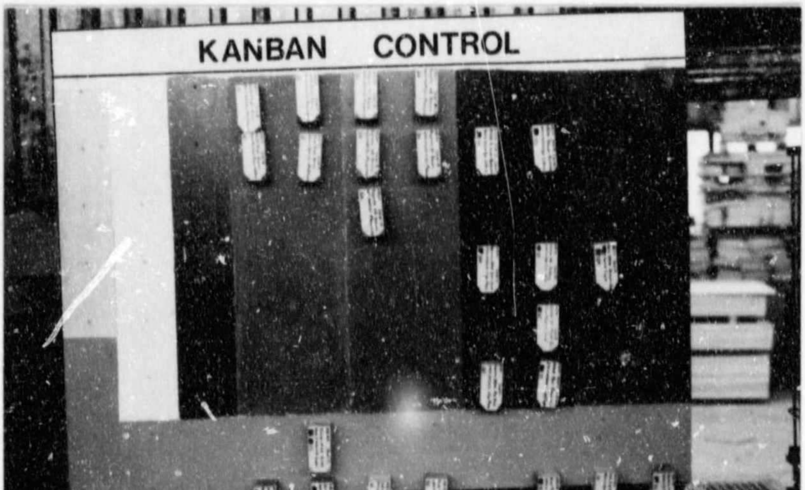
The steering committee decided to again redesign the Kanban cards and colour code them according to the line which they supplied. For example, kists were colour coded yellow, bedroom suites blue or black depending on whether they supplied the JIT line or the extras line and displays were coded in red. On the introduction of the new Kanban cards in January 1988 lot sizes were cut to 3 days worth of supply. Lot sizes were now extremely small. Print 11 shows one of the January 1988 Kanban cards. The card contains a Kanban card number, in this case 'KB136', a set number, 'STEL C', a description of the component, 'Standard kist tray front and back', a size, 952 x 130 x 12, and the BOM quantity i.e. (1-2) indicating that 2 components are required per kist. The material to be used is Supa or Supawood. The lot size is 10 units. Not visible on the print is the component routing through the machine shop. The routing is written on the underside of the block, and is used by the material handlers to guide the movement of components through the factory.



PRINT 11: Stage 3 Kanban card.

Rather than have 1 Kanban card and a large lot it was decided that lot sizes should be reduced continuously. In the example above the lot size is down to 10 units from a previous 1000 {(500 x 2) 1 fron 1 back see section 4.5.2}. Since 10 standard kists may be manufactured in a day and the lead time for the Kanban KB136 to flow through the plant was approximately 3 days it was necessary to introduce a few sets of each Kanban into the system. Thus, 'STEL C' means that this card is one of the third set of cards for this particular component. The system ensured that some of each component would be available each day.

The Kanban board, still positioned at the board breakout centre, was also colour coded. This colour coding helped the machine shop foreman to be aware of what lines needed which components [Print 12]. The priority sequencing of jobs that appeared on the board always follow a first-come-first-served sequencing rule according to the JIT philosophy.



PRINT 12: Colour coded Kanban board.

Table 5 summarizes the Kanban implementation project and its associated reductions in machine shop lotsizes.

KANBAN CARD TYPE	DATE STARTED	NUMBER INTRODUCED	SAMPLE LOTSIZE	LOTSIZE REDUCTION
Coloured flat square Print 8	May 1987	± 50	1000	Nil
White square and block Print 9	June 87	200	500	50%
As above but corrected	Sept 87	600	250	50%
As above also corrected	Nov 87	650	80	68%
Coloured blocks Print 11	Jan 88	800	10	88%

TABLE 5: Summary of Kanban implementation.

4.6 Spinoffs from the Pilot Projects

4.6.1 Product and Component Rationalisation

The reduction of lot sizes, in some cases from 1000 units to 10 units, in the machine shop at A.F. Dreyer created an environment where many small lots were processed each day. As a result machines had to be set up far more frequently than before JIT implementation. The company approached the "high load on the machine shop" problem by embarking on a parent item rationalisation program and a component standardisation program.

After an analysis of unit sales data it was found that approximately 90 of the 240 end items were selling less than one unit per month (average taken over 15 months - see Appendix 3). These 90 units were eliminated from future sales catalogues.

Since, on average, each parent item contains 25 components, over 2000 components were eradicated from the design files. Although there was not a physical inventory of all the components, a store measuring ±240 square meters, was now filled with old stock which had to be worked out of the system.

As regards component standardisation, four small projects were undertaken by the production staff. The first involved redesigning the side pedestals for headboards and dressing tables. Rather than manufacturing a different size pedestal for every model of bedroom suite, it was decided that 3 standard sizes would be used i.e. small, medium and large. Apart from one of the three sizes, each suite design would have a different pedestal door and handle only.

The second project, "support standardisation", involved the standardisation of supports which are wooden blocks that hold the headboard padding in place. Prior to the implementation of JIT, every time a new headboard was introduced, the supports would be a slightly different size or shape. The original 150 different supports were eliminated in favour of 15 general supports which were now coded alphabetically rather than by bedroom suite names. After the first stage of rationalisation these supports were predrilled blocks which were screwed onto the headboards to support the padding. Later however the undrilled blocks or "blanks" were drilled at the assembly line and thus only one part number was needed, (for either a right hand side or a left hand side application) rather than two mirror image part numbers. Print 13 indicates the small stock of "blank" supports with their associated Kanban cards in the component store.

PRINT 13: "Blank" supports and associated Kanban cards.

The third standardisation project involved the elimination of all but one, of the previously designed wardrobes. A "New Robe" was designed which was in effect, a wardrobe without doors. Different doors were fitted to the robe depending on what bedroom suite the robe was to match. In addition, the drawer units inside the robe were modular such that different drawer units could be fitted to the standard "New Robe" frame.

The fourth standardisation program was the "kist size standardisation" program. In a bid to reduce the amount of changes in setups in the machine shop it was decided that the different model kists would all be one of three standard sizes. Jigs were built to aid in faster setups with machinery such as crosscut saws, routers and surfacers.

4.6.2 Sanding Shop Project

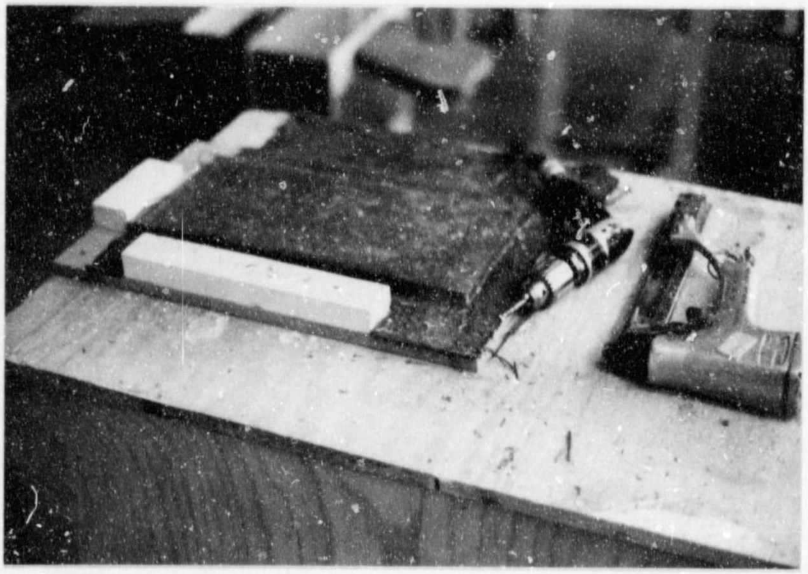
After noting how well the "split sand"[described below] concept worked on the kist assembly line it was decided that the concept would be adopted into the polish shop. Rather than each sander sanding an entire unit of furniture, the sanders were organised into "production lines". The lines were dedicated to one particular type of furniture. A time study was carried out and the sanding task on each unit was split evenly among the number of sanders in the line e.g. In one particular line, the first sander sanded the table top, the second the edges of the top and one leg, and the third the remaining three legs. [84] It was found that the production rate increased as the workers now worked as a team synergistically rather than individually. In addition, many JIT concepts such as Kanban squares and worker centred quality control could now be applied.

The sanding shop project had a positive motivating effect on the labour force. The workers showed more interest in their work and an informal competition developed among the three sanding lines. The author believes that a productivity increase of 9% which was noted, was a direct result of increased job satisfaction that stemmed from responsibility having been transferred from the foreman down to the shop floor labour.

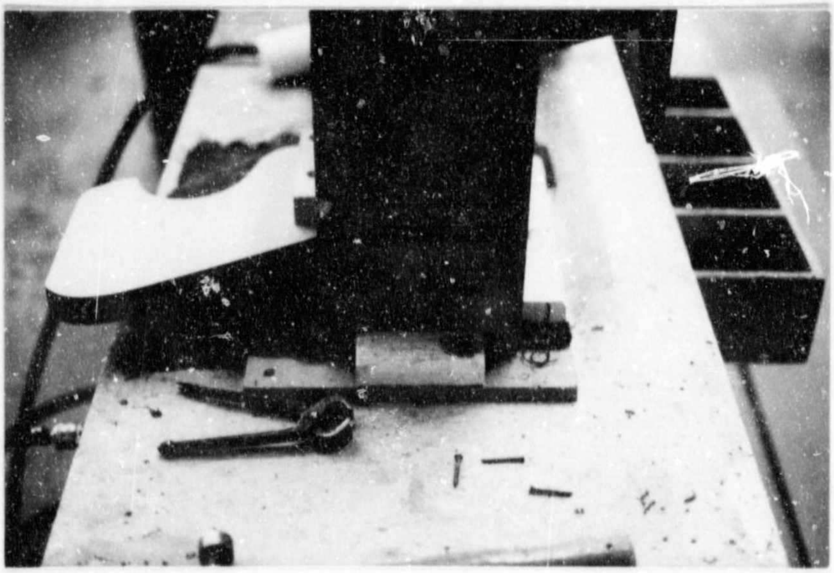
4.6.3 Quality Circles, Problem Solving and Creative Involvement

Although only two quality circles were set up, the results of the work was encouraging. Rather than discuss the objectives and organisation of the quality circles this section serves only to present some of the solutions to the problems tackled.

<u>Problem 1:</u> The bedroom suite line was faced with a need for a fixture to hold the pedestal of a headboard while the padding was being attached. The group solved the problem by designing a jig shown in Print 14 and 15. Rather than cover the entire table with a blanket to stop scratches occurring, the blanket was only used where the pedestal touched the workbench.



<u>PRINT 14:</u> Headboard jig with "waste saving padding".

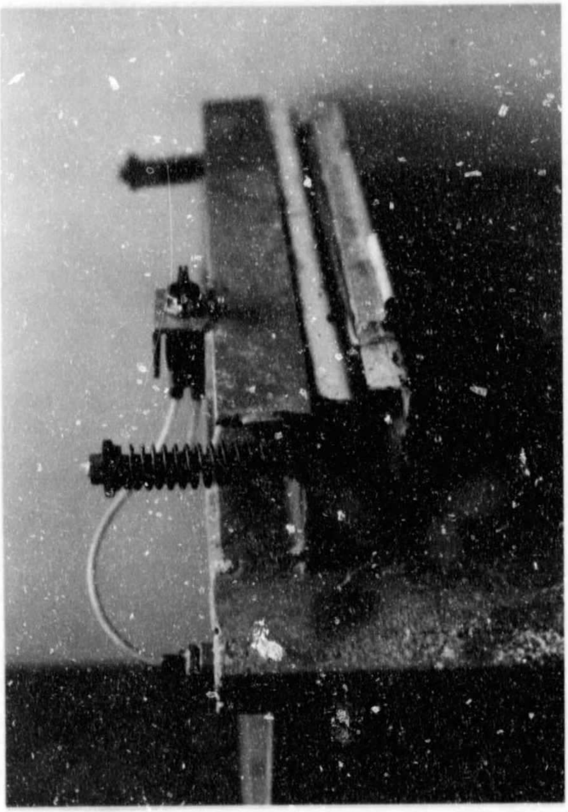


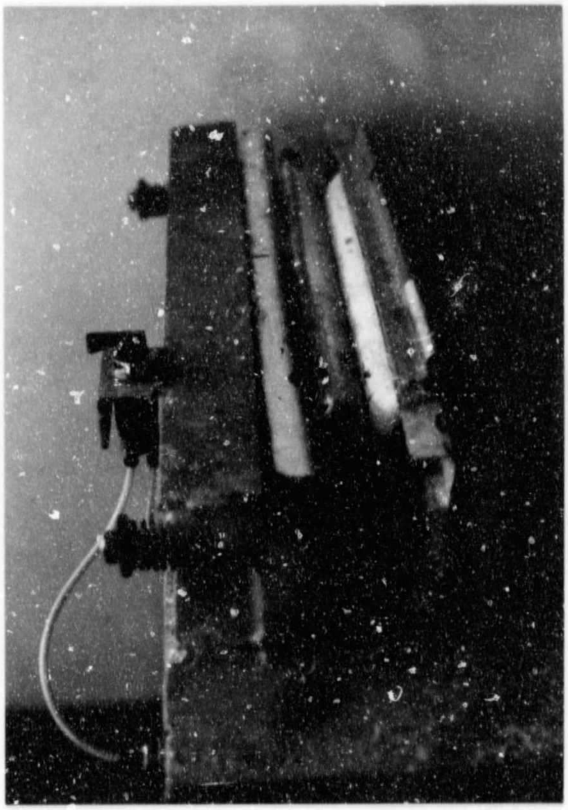
<u>PRINT 15:</u> Headboard jig in use.

Problem 2: The kist assembly line was faced with the problem of first having to drill a hole through the kist lid frames and then countersinking this hole. Since the task of drilling twice was too time consuming the problem was approached and solved by grinding down a large drill bit in-house to the correct sizes and sharpening both the point and the shoulder. The home-made "form drill" is shown in Print 16.

PRINT 16: Redesigned countersinking drill bit.

Problem 3: A drawer clamp was required by the bedroom suite line to assemble drawers. Since pneumatic or hydraulic piston clamps were expensive and manual screw type clamps too slow, a different solution was required which functioned fast but at a low cost. Print 17 and 18 show the design that was developed and fabricated in-house.





PRINT 17: Drawer press (open)   PRINT 18: Drawer press (closed)

Two pieces of fire hose, clamped shut at the ends by short pieces of piping, are filled with compressed air which is freely available in the plant. The fire hose expands and closes the press. To open the press, the air pressure is released and the press is opened by means of two spring loaded bolts.

It is important to note that the quality circle group members felt that the most effective reward for creative involvement is the satisfaction that the circle members gain from solving problems and actually observing the implementation of their solutions.

4.6.4 Preventative Maintenance

No attempt was made during the first half of 1987 to introduce a project concerning preventative maintenance primarily because machine breakdowns were not noticeable and did not have severe consequences. Due to the seasonality of the furniture industry, the flow volumes were not substantial during the first half of the year. After the introduction of Kanban cards and the reduction of lot sizes and buffer stocks machine breakdowns became more noticeable, more common, and more severe. They were more common probably due to the higher load on the machines with the processing of many small lots, frequent setups, as well as climbing orders before the year end and Christmas season. The breakdowns were more severe since buffer stocks were low and downtime meant lost sales. Towards the end of 1987 the breakdown rate of machine shop equipment reached drastic proportions with a major machine going down virtually every week. The steering committee decided to start a preventative maintenance program during the initial quiet months of 1988.

4.6.5 The Kanban Trolley System

Although a pull system had been set up between the assembly shop and the breakout areas of the machine shop by means of the Kanban card system, no pull system existed between individual workcentres within the machine shop.

A study was conducted on the routing information for the top 20% of the parent items which accounted for 80% of the sales volume and thus the flow volume through the machine shop. The result indicated that there were numerous machine centres between which large quantities of components moved. The highest flow volume occurred between a multi borer drill and the Ultra-Violet polish line. Since one of the constraints of the project disallowed large financial investment, heavy machinery could not be moved. (the relayout of a furniture plant is very expensive due to the ducting connected to every cutting machine for the dust extraction units) The drill and the Ultra-Violet line were at opposite ends of the plant [see layout as at February 1987 Appendix F].

Initially trolleys of components were drilled at the multi borer and then, on completion, moved to the holding zone at the polish line regardless of how many units were already waiting at the polish line. Thus, although the overall ordering between assembly and fabrication was a pull system, units were still being pushed through each fabrication centre. The Kanban trolley system served to alter this push strategy to a pull strategy.

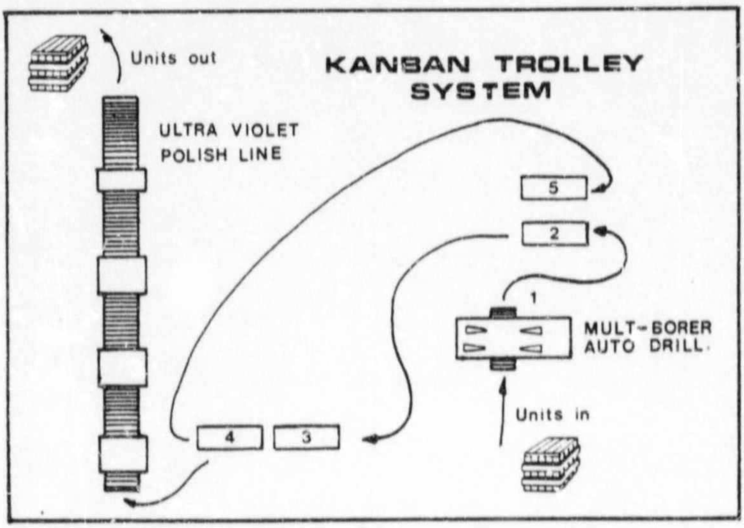
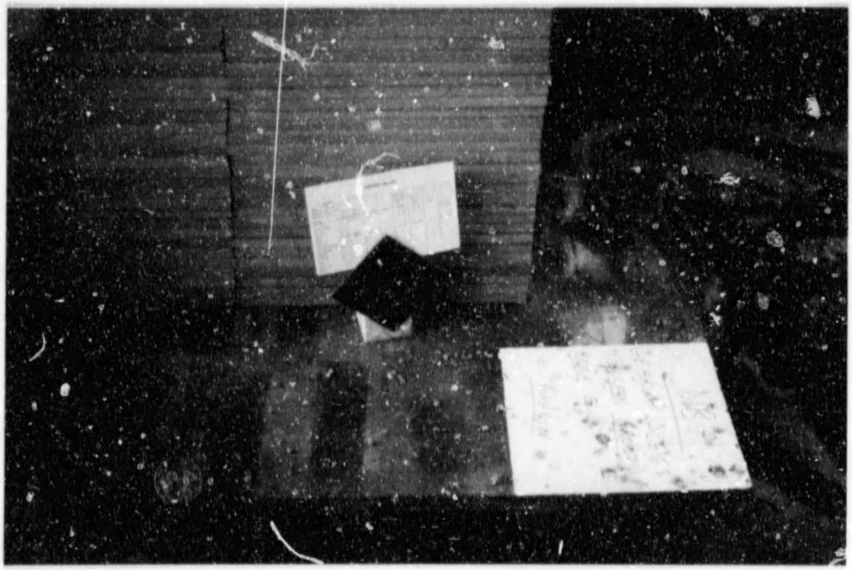


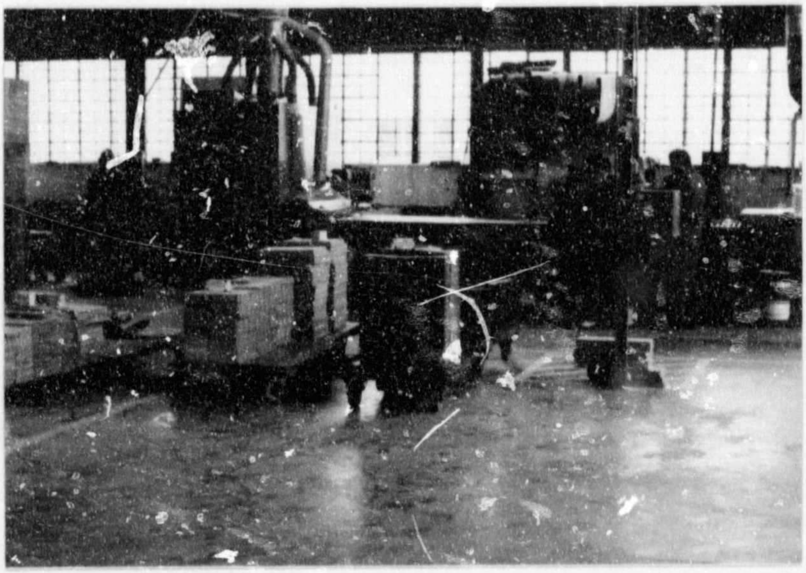
FIGURE 16: The Kanban trolley system.

The Kanban trolley system is depicted in Figure 16. The system works as follows -

- Drilled components emerged from the multi borer at point 1. The components are then placed onto a red Kanban trolley, of which there are 4, with their Kanban card. (2) [Print 19]
- The trolley load of components is then moved to a holding queue at the head of the polishing line. (3) [Print 20]
- When the trolley reaches the front of the queue (4) , its contents are fed through the polish line and the red Kanban trolley is returned empty to the multi borer (5).
- The multi borer operator only produces components for the polish line when he has one or more trolleys at the multi borer. The Kanban trolley is thus a signal for the multi borer to produce.



PRINT 19: Red Kanban trolley with a stage two Kanban card



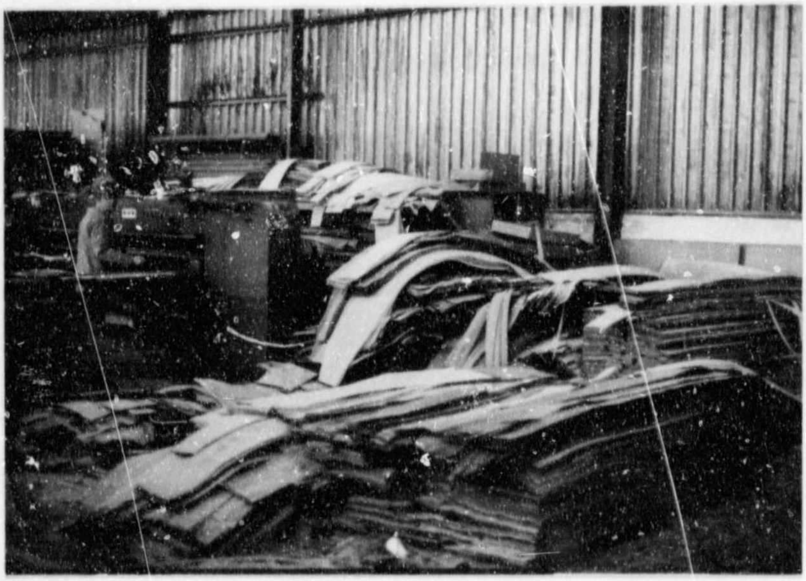
PRINT 20: Two red Kanban trolleys at polish line.

Four trolleys were used initially so as to reduce the shock of the change from a push system to a pull system. Over time it was envisioned that trolleys would gradually be removed until only the bare minimum remained to handle flow between the distant machines.

Although a plant relayout was being considered, the plans were long term. In the event of a relayout of the machine shop, group technology and cellular manufacturing would be the primary criteria for relayout. The relayout would include the entire manufacturing and assembly areas for each product line.[see section 4.8] It was believed that the Kanban trolley system would be applied between cells rather than between actual machines. The Kanban trolley is simply a moving Kanban square.

4.6.6 Housekeeping and Visibility

The importance of improving generally poor housekeeping and visibility in the furniture industry cannot be overstated. Prints 21 & 22 show scenes of poor housekeeping in the industry.



PRINT 21: Poor housekeeping in a veneer cutting area.

PRINT 22: Poor housekeeping in a padding store.

Quality control is perhaps the chief reason for good housekeeping but safety and pride are important related factors which contribute positively towards motivation. As Schonberger [85] indicates "sloppy housekeeping habits encourage sloppy work habits". Poor work habits may lead to injury, damage to equipment and low productivity. Conversely good housekeeping should result in an environment conducive to improved work habits, quality, care of equipment and increased productivity. At A.F. Dreyer, although no actual housekeeping project was started, workers were encouraged at training sessions and meetings to keep their work areas tidy. In as much as good housekeeping contributes to good quality the housekeeping responsibility must reside with those who have quality responsibility namely the foreman and workers.

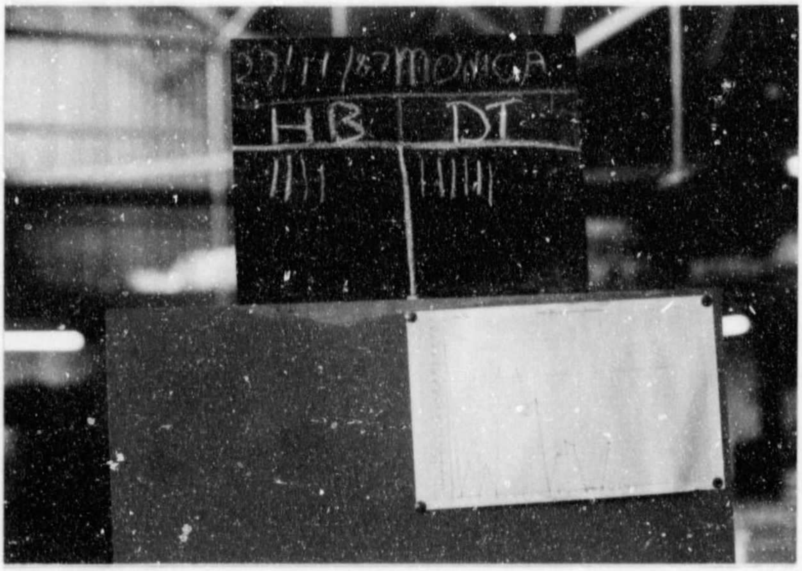
Two examples of good housekeeping at A.F. Dreyer are shown in Prints 23 and 24. Print 23 shows two polish shop workers, in a clean tidy environment, discussing a quality problem on a kist's hinge limits prior to the polishing of the kist. Print 24 shows the planning desk, jigs and Kanban board at the solid wood breakout centre.

In a similar way, visibility enhances productivity and performance. The use of wall charts, chalk boards, graphs and Kanban boards encourages workers to become involved in the daily operation of the plant. Visibility improves the workers' understanding of the system and helps motivate the workers. The worker who understands the system participates in the system. At A.F. Dreyer it was found that when charts and graphs were introduced into an area there was generally a noticeable improvement in moral and enthusiasm.

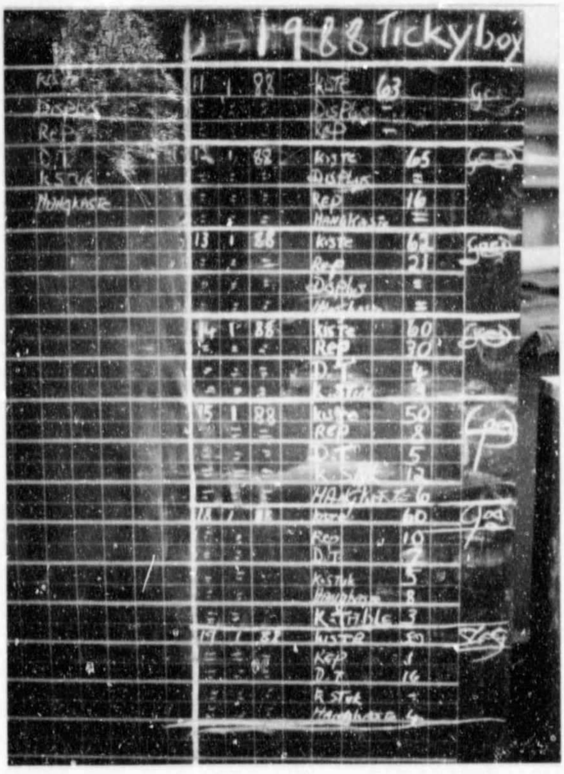
PRINT 23: Two workers discussing quality in a tidy environment.

PRINT 24: Solid breakout planning desk, jigs and Kanban board.

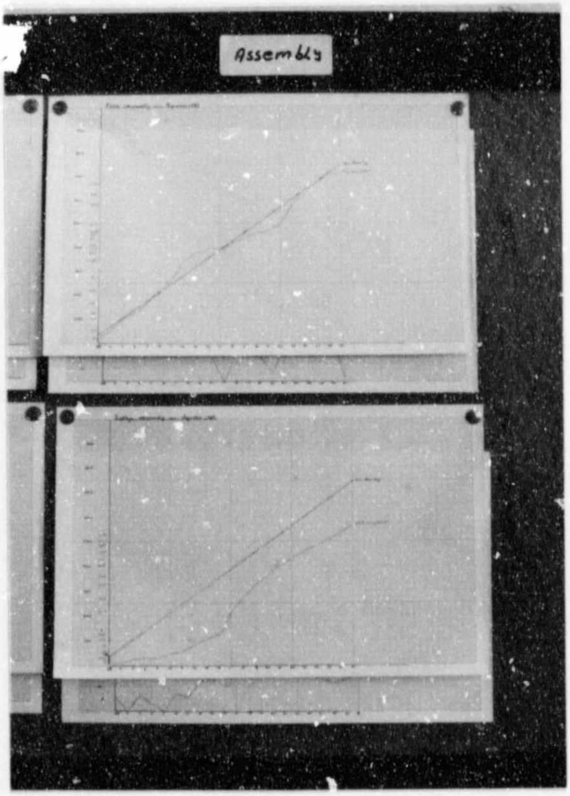
Prints 25, 26 and 27 show some examples of visibility at A.F. Dreyer. On the introduction of visibility improvement at the company there was a marked increase in enthusiasm interest and production output in the areas concerned. In addition workers became far more aware of quality.



PRINT 25: Chart showing production activity on the headboard line.



PRINT 26: Table showing production activity in the spray shop.



PRINT 27: Chart showing target and actual final assembly schedules.

4.7 The Strike and its Impact

In the middle of June 1987 workers at A.F. Dreyer went on strike. The strike, which started on 16 June 1987 was the result of two factors; 1) National unrest at the time of the strike (anniversary of the 1976 Soweto Protests) and 2) managements' refusal to accept a COSATU affiliated trade union as a representative union of the labour force. The workers at A.F. Dreyer had been represented by FWU (Furniture Workers Union) for over 30 years and management was adamant that the FWU would remain the representative union of the workers. The author approached the management at the time of the strike and was